U.S. Army Corps
of Engineers

Louisiana Coastal Protection and Restoration

ENCLOSURE C

Louisiana Economy and 2005 Hurricane Damage

Preliminary Technical Report to Congress

June 2006

The Louisiana Economy

The economic contribution of the New Orleans metropolitan area to the Nation is closely aligned with its geographical placement at the head of the largest economically developed drainage basin in the western hemisphere. The greater New Orleans area is a major international port and transportation hub for waterborne and interstate commerce. Half of the Nation's grain exports are processed within the port complex centered in New Orleans. The economic backbone of the regional economy is comprised of the Port of New Orleans, the Port of South Louisiana, and the Port of Baton Rouge. Collectively, it is the largest port complex in the United States handling over 360 million tons of cargo in 2004 which represents nearly 12% of the Nation's total tonnage. New Orleans also facilitates interstate commerce as it serves as the hub of the Gulf Intracoastal Waterway (GIWW), which reaches from Brownsville, Texas to Apalachicola, Florida and serves as a critical element of the larger inland navigation system of the United States. The GIWW connects to the Mississippi River in New Orleans and provides shallow-draft access of vessels engaged in waterborne commerce to areas deep into the Nation's interior such as in Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana, Ohio, Tennessee, Kentucky, Pennsylvania, and West Virginia. A significant amount of U.S. industrial output is dependent upon the efficient transportation of crude petroleum, petroleum products, and coal on the GIWW.

The central role of the New Orleans metropolitan area in the economic development of the Mississippi Valley and beyond is disproportionately greater that other port cities because of its additional role as a major center for the Gulf Coast petrochemical industry. Regional economic growth plans recognize the overwhelming benefits that accrue to hub cities that are situated in delta regions, yet these benefits are invariably offset by the higher levels of riverine or coastal flood risk. New Orleans' unique geographic location supports its multiple functions as a gateway port, transportation hub, and anchor to regional development. There is no other single location along the Gulf Coast that can effectively provide these same functions. Therefore, the management and potential enhancement of existing flood control projects in Southeast Louisiana, including ecosystem-centered features, represent a supplemental investment in the economic infrastructure of the Nation.

In Southwest Louisiana, the Port of Lake Charles and the Lake Charles metropolitan area serve a critical function in the delivery, refining, and distribution of petroleum and petroleum products as an integral part of the Nation's energy infrastructure. This area also faces risks from storm surge; landfall from a storm of greater magnitude than Rita is possible for this region. In such an event, the devastation to the U.S. energy infrastructure would be greater than that previously experienced with Rita.

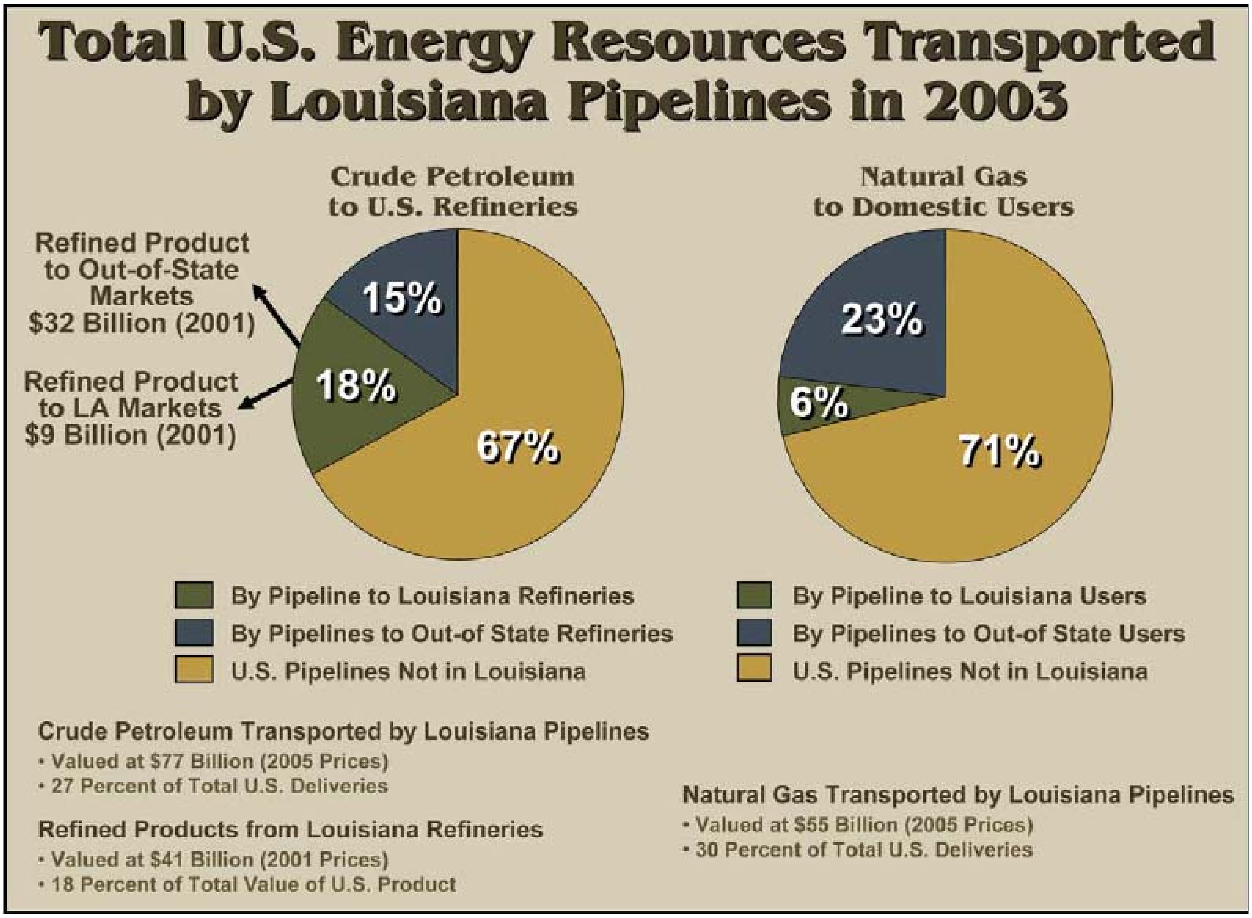
In addition to New Orleans and Lake Charles there are five other deepwater ports in Louisiana: the Port of Baton Rouge, Morgan City, the Port of South Louisiana, the Port of Plaquemines, and Port Fourchon which is strategically located at the mouth of Bayou Lafourche and serves as a critical supply and support base for oil and gas exploration and development in the Federal offshore oil leases. Louisiana supports significant international trade through each of these seven deepwater ports. Based on throughput, four of these Louisiana ports are ranked among the top eleven largest U.S. ports.

Exploration and development of hydrocarbon resources in the Gulf of Mexico is supported by a system of supply ports along the southeastern coast of Louisiana. Land-based facilities in Morgan City, Houma, Larose, Golden Meadow, Empire, Buras, and Venice are protected by existing hurricane protection projects. Although Port Fourchon is particularly prominent as an offshore supply base, its location at the mouth of Bayou Lafourche leaves it and its access route, Louisiana Highway 1, outside of the limits of hurricane protection. Yet, with effective protection against storm surges further inland, the close proximity of Port Fourchon to the protected areas would enable it to quickly recover from storm damages. This would enhance and preserve the Port's capability to serve as the strategic base for repair of the offshore exploration and production facilities, including the vital Louisiana Offshore Oil Port (LOOP), a deepwater facility that handles 13% of total U.S. crude petroleum imports and which connects to 35% of the U.S. refining capacity.

Perhaps most revealing, however, is that approximately 25% of the Nation's total oil production originates in Louisiana and the Federal offshore leases that are served by Louisiana. The 2004 production level of 1.26 million barrels per day, if separated from the rest of the U.S. production, would place Louisiana among the top 20 global oil producers. Louisiana and the adjacent Federal offshore leases, accounted in 2004 for approximately 20% of the proved reserves in the United States. This is a significant proportion of the Nation's reserves because much of the Nation's other reserves are located in Alaska and in Federal waters offshore of California and Florida which are currently excluded from future development.

The Nation's energy sector is heavily dependent upon the development of oil and gas exploration, production, and petrochemical refining along the coasts of Texas and Louisiana. The massive pipeline infrastructure in the coastal zone of Louisiana is particularly vulnerable to disruption during tropical events. Although only a portion of the pipeline lies within existing or proposed hurricane protected areas, effective hurricane protection systems, particularly for rare, catastrophic events are important. Because the staging areas for recovery would be located within protected areas, the recovery from interrupted energy transportation can occur securely and more rapidly. Louisiana pipelines transport approximately 33% of the Nation's domestic and imported crude petroleum and approximately 29% of natural gas to domestic users. **Figure C-1** summarizes this distribution as most recently reported by the U.S. Department of Energy and the Louisiana Department of Natural Resources.

Louisiana ranks second in refinery output in the United States and has more than 100 industrial plants that manufacture 25% of all petrochemical products nationwide. Confidence in a reliable and effective system of protection from coastal storm surges would tend to mitigate market swings and temper supply disruptions as recovery operations are accelerated for facilities lying within the hurricane protection project and access to facilities lying outside of the project requiring inspection and repair would be more immediate and effective. Because the energy futures market accounts for up to 25% of energy prices, confidence in a trans-coastal hurricane protection system, integrating ecosystem restoration with structural features, would tend to reduce the volatility in the market even for rare, potentially catastrophic tropical events that may threaten the coast, even without making landfall.



Source: U.S. Department of Energy and Louisiana Department of Natural Resources

From this perspective, New Orleans, Lake Charles and the remainder of coastal Louisiana infrastructure serve an integral national security function by supporting energy independence, balance of trade, and the efficient and effective transportation of a vast inventory of intermediate commodities used in refining and manufacturing.

Coastal Louisiana also is an exporter of sulfur, salt, forest products and agricultural commodities such as rice, sugar, and soybeans. Louisiana commercial fisheries provide an important national economic resource. The Louisiana Department of Wildlife and Fisheries recently reviewed the impact of Louisiana fisheries, wildlife, and boating resources on the Nation's economy. Coastal wetland habitats in Louisiana support a seafood industry with an annual economic impact in 2003 that exceeded $2 billion. Combined with menhaden landings (not used as seafood), the economic effect of marine fisheries was about $2.6 billion. The combined volume of commercial seafood and menhaden landings is comparable to the entire volume of commercial fish and shellfish along the Atlantic Seaboard and is three times that of the remaining U.S. Gulf Coast. This productivity accounts for 25% of all seafood landing in the Nation, second only to Alaska. These same wetlands support a sport hunting industry in the Louisiana that had an economic effect of another $1 billion in 2003. The economic impact of wild and farmed alligator industry was estimated to be $69 million while crawfish was $42 million in 2003. Recreational saltwater fishing in the State was estimated to have an economic effect of $792 million.

Population at Risk

The 2000 Census of Population counted 2,480,000 permanent residents in 23 Louisiana parishes, all or part of which are included in the State's coastal zone (**Table C-1**). This figure represents over 55% of the total population of the State. These residents and the economic and social resources that are associated with urban and rural development are at risk from any of the rare, catastrophic tropical events that are evaluated in this technical report. Although effective evacuation plans can move a significant portion of the population away from the area of storm surge, the population estimates serve primarily as an indicator for the economic infrastructure that remains vulnerable. Residential housing alone is estimated by the 2000 Census to account for over one million units at risk (**Table C-2**).

Table C-1. Population at Risk in the Louisiana Coastal Zone with Historical Population Trends Based on the 2000 U.S. Census

Parish	1970	1980	1990	2000	1970-1980 % Change	1980-1990 % Change	1990-2000 % Change
Acadia	52,109	56,427	55,882	58,864	8.3	-1.0	5.3
Ascension	37,086	50068	58,214	76,627	35.0	16.3	31.6
Assumption	19,624	22,084	22,753	23,388	12.5	3.0	2.8
Calcasieu	145,415	167,223	168,134	183,577	15.0	0.5	9.2
Cameron	8,194	9,336	9,260	9,991	13.9	-0.8	7.9
Iberia	57,397	63,752	68,297	73,266	11.1	7.1	7.3
Jefferson	337,568	454,592	448,306	455,466	34.7	-1.4	1.6
Jefferson Davis	29,554	32,168	30,722	31,435	8.8	-4.5	2.3
Lafayette	109,716	150,017	164,762	190,503	36.7	9.8	15.6
Lafourche	68,941	82,463	85,860	89,974	19.6	4.1	4.8
Orleans	593,471	557,515	496,938	484,674	-6.1	-10.9	-2.5
Plaquemines	25,225	26,049	25,575	26,757	3.3	-1.8	4.6
St. Bernard	51,185	64,097	66,631	67,229	25.2	4.0	0.9
St. Charles	29,550	37,259	42,437	48,072	26.1	13.9	13.3
St. James	19,733	21,495	20,879	21,216	10.6	-2.9	1.6
St. John the Baptist	23,813	31,924	39,996	43,044	34.1	25.3	7.6
St. Martin	32,453	40,214	43,978	48,583	23.9	9.4	10.5
St. Mary	60,752	64,253	58,086	53,500	5.8	-9.6	-7.9
St. Tammany	63,585	110,869	144,508	191,268	74.4	30.3	32.4
Tangipahoa	65,875	80,698	85,709	100,588	22.5	6.2	17.4
Terrebonne	76,049	94,393	96,982	104,503	24.1	2.7	7.8
Vermilion	43,071	48,458	50,055	53,807	12.5	3.3	7.5
Washington	41,987	44,207	43,185	43,926	5.3	-2.3	1.7
IMPACT AREA	1,992,353	2,309,561	2,327,149	2,480,258	15.9	18.0	6.5

Source: U.S. Department of Commerce, Bureau of the Census (2000).

Table C-2. Residential Housing Units at Risk in the Louisiana Coastal Zone Based on the 2000 U.S. Census.

Parish	2000
Acadia	23,209
Ascension	29,172
Assumption	9,635
Calcasieu	75,995
Cameron	5,336
Iberia	27,844
Jefferson	187,907
Jefferson Davis	12,824
Lafayette	78,122
Lafourche	35,045
Orleans	215,091
Plaquemines	10,481
St. Bernard	26,790
St. Charles	17,430
St. James	7,605
St. John the Baptist	15,532
St. Martin	20,245
St. Mary	21,650
St. Tammany	75,398
Tangipahoa	40,794
Terrebonne	39,928
Vermilion	22,461
Washington	19,106
IMPACT AREA	1,017,600

Source: U.S. Department of Commerce, Census Bureau (2000).

For hurricane protection projects that are in place, under construction, or have completed study, the protected population is 1,129,600. Detailed estimates by project are included in **Table C-3**. The total population left unprotected within the parishes that currently incorporate parts of these hurricane protection projects is approximately 147,000, or about 11% of the total population of those parishes, as shown in **Table C-4**. However, the hurricane protection projects identified in **Table C-4** are not designed to protect against the rare “Category 5’tropical event that is subject of this technical report.

Table C-3. Population Protected by Existing or Proposed Federal Hurricane Protection Projects in Southeastern Louisiana Based on the 2000 U.S. Census.

Hurricane Protection Project	Protected Population
Shoreline Protection Works - Authorized and Completed	
Grand Isle, LA and Vicinity	
Jefferson Parish	
Town of Grand Isle	1,311
Shoreline Protection Works Subtotal	1,311
Levee Systems - Authorized and Under Advanced Construction	
Lake Pontchartrain Hurricane Protection Project, LA and the West Bank, in the Vicinity of New Orleans, LA	
Orleans Parish	481,031
East Bank	424,249
West Bank	56,782
Jefferson Parish	444,875
East Bank	257,501
West Bank	187,374
St. Bernard Parish	65,929
St. Charles Parish	
East Bank	24,081
Plaquemines Parish	
West Bank	9,850
Larose to Golden Meadow, LA	
Lafourche Parish	21,600
Larose	5,050
Cutoff	5,635
Galiano	7,356
Golden Meadow	2,193
Unincorporated	5,866
New Orleans to Venice, LA	
Plaquemines Parish	11,498
Reach A - West Bank	4,089
Reach B - West Bank	5,597
Reach C - East Bank	1,812
Levee Systems – Authorized and Under Advanced Construction Subtotal	1,060,265
Levee Systems - Approved and Awaiting Authorization	
Morganza to the Gulf, LA	
Lafourche Parish	16,423
Terrebonne Parish	52,894
Levee Systems – Approved and Awaiting Authorization Subtotal	69,317
Grand Total	1,129,492

Table C-4. Population in Areas Unprotected by Existing or Proposed Federal Hurricane Protection Projects in Southeastern Louisiana

Parish Population Based on the 2000 U.S. Census				
Parish	**Total**	**Protected**	**Unprotected**	**% Unprotected**
Jefferson	455,466	446,186	9,280	2.0%
Orleans	484,674	481,031	3,643	0.8%
St. Bernard	67,229	65,929	1,300	1.9%
St. Charles	48,072	24,081	23,991	49.9%
Plaquemines	26,757	21,438	5,319	19.9%
Lafourche	89,974	38,023	51,951	57.7%
Terrebonne	104,503	52,894	51,609	49.4%
Total	1,276,675	1,129,582	147,093	11.5%

Recent Flood History in Coastal Louisiana

Several tropical storms and hurricanes of unusual severity have threatened or made landfall on the Louisiana coastline in the past 40 years. The tidal surges associated with these tropical events have inundated thousands of structures and resulted in billions of dollars of damages. Intense rainfall activity, both tropical and extratropical, has also caused extensive damage to major urban areas in coastal Louisiana, as reported below, and is only partially mitigated with Federal flood control projects.

Table C-5 summarizes the damages associated with the most significant tropical events affecting Louisiana since the early 1960s. All dollar damages are reported at 2006 price levels. In 1965, Hurricane Betsy inundated over 25,000 homes in 18 parishes, with damages of approximately $3 billion. Tidal surges and rainfall associated with Hurricane Juan in 1985 inundated over 2,000 homes in two large subdivisions on the westbank of Jefferson Parish, and resulted in nearly $400 million in insured losses. In 1992, Hurricane Andrew after traversing Florida with devastating effects, struck the central coast of Louisiana and flooded over 25,000 homes in the communities south of the city of Houma, causing damages approximating $2.6 billion. During a 5-year period (1998-2002) three tropical storms and 1 hurricane made landfall in southeast Louisiana. The combined damage from these four storms is over $1.6 billion.

Table C-5. Summary of Major Flood Events.

Flood Event (Year)	Source of Flooding	Impacted Area	Number of Structures Inundated[c]	FEMA Claims[a] (thousands)	Total Damages[b] (thousands) Original Costs	2006 Costs
Hurricane Rita (2005)	Tidal	Southwest Louisiana	10,000	$ 1,000,000[d]	$ 5,000,000	$ 5,000,000
Hurricane Katrina (2005)	Tidal	Southeast Louisiana	147,000	$12,500,000[d]	$ 90,000,000	$90,000,000
Hurricane Ivan (2004)	Tidal	Southeast Louisiana	n/a	n/a	n/a	n/a
Hurricane Lili (2002)	Tidal	Houma and North shore of Lake Pontchartrain	7,356	$ 400,000	$ 894,600	$ 1,052,503
Tropical Storm Isidore (2002)	Rainfall and Tidal	North shore of Lake Pontchartrain	2,905	$ 71,000	$ 383,400	$ 451,073
Tropical Storm Allison (2001)	Rainfall and Tidal	Lafourche and East Baton Rouge Parishes	4,060	$ 44,548	$ 55,440	$ 67,231
Tropical Storm Frances (1998)	Rainfall and Tidal	Jefferson and Plaquemines Parishes	1,000	$ 10,500	$ 23,000	$ 29,884
May 1995	Rainfall	New Orleans	42,927	$ 572,266	$ 1,155,400	$ 1,624,445
Hurricane Andrew (1992)	Rainfall and Tidal	Houma	24,887	$ 55,672	$ 1,681,500	$ 2,594,603
May 1991	Rainfall/ Backwater	Houma/Thibodaux	1,493	$ 22,825	$ 30,435	$ 48,419
Hurricane Juan (1985)	Rainfall and Tidal	Coastal Louisiana and West Bank of Mississippi River	2,200	$ 70,000	$ 216,024	$ 396,104
Amite/Comite (1982)	Backwater	Baton Rouge	3,500	$ 164,185	$ 171,721	$ 345,328
Spring (1973)	Backwater	Morgan City Industries	26	$ 557	$ 7,000	$ 28,414
Hurricane Betsy (1965)	Tidal	Southeast Louisiana	25,941	n/a	$ 371,960	$ 2,946,567

Source: New Orleans District U.S. Army Corps of Engineers, Post Flood Reports and preliminary estimates for Hurricanes Katrina & Rita

[a] Values representing Federal Emergency Management Agency (FEMA) claims are based on the price level of the year that the flood claims were paid but were adjusted to reflect a constant price level (March 2006).

[b] Total damages include structural, vehicle, agricultural, and emergency costs for parish, State, and local governments in Louisiana only, except for Katrina and Rita which do not include emergency costs.

[c] The number of residential structures inundated by Hurricanes Katrina and Rita are based on Red Cross surveys and newspaper articles.

[d] FEMA flood claims for Hurricanes Katrina and Rita are preliminary and continue to be tabulated.

Hurricanes Georges in 1998 and Ivan in 2004 tracked just beyond the margin of the New Orleans metropolitan area, inducing full-scale evacuation from the region. Although these storms did not make landfall in the densely populated areas of the State, the magnitude and potential destructive power of Georges and Ivan was enormous. At a minimum, storm surges caused damages in

Plaquemines and St. Bernard parishes, but no agency reports exist that documents the level of these damages. The track of Georges and Ivan was similar to that of Katrina, except that they passed farther to the east of the city. Otherwise, New Orleans would have experienced higher storm surges and potentially significant damage.

In August of 2005, Hurricane Katrina made landfall in southeastern Louisiana, causing over $90 billion in physical losses. Slightly over 147,000 structures in the New Orleans metropolitan area were inundated and over 1,293 fatalities were counted in Louisiana alone. Less than a month later, Hurricane Rita made landfall on the southwest coast of Louisiana, resulting in the flooding of approximately 10,000 structures and causing over $5 billion in damage in the State.

The $90 billion estimate of losses associated with Hurricane Katrina is a preliminary assessment of the minimum direct physical damages that was prepared by the New Orleans District. It uses data that was collected by the American Red Cross, the Insurance Information Institute, the Louisiana Recovery Authority, and the Louisiana State University Agricultural Center. The Interagency Performance Evaluation Team (IPET) will publish a more detailed and comprehensive set of damage estimates for the New Orleans metropolitan area in the 1 June 2006 Final Report. A similar approach was used to estimate damages associated with Hurricane Rita which totaled $5 billion, on a preliminary basis.

Flood-related damages to structures, contents, and vehicles were estimated by using field data collected from the Red Cross which was limited to the number of structures damaged and broad classifications of damage as it relates to the degree of severity. Data that were previously developed in support of past flood control studies that measure the damage response of structures to various levels of flooding were used to convert the Red Cross estimate of “affected” structures into its dollar equivalent. This estimate ranges from $25 to $30 billion. It should be emphasized that numerous generalizations were made in order to expeditiously develop an interim estimate. Again, a more detailed and refined estimate of total physical damage is an objective of the IPET.

Residential damages due to wind ($10 - $14 billion), were obtained from homeowner insurance claims as reported by the Insurance Information Institute.

Flood and wind damages to commercial property ($30 - $50 billion) and damages to utilities and pubic infrastructure ($23 - $30 billion) were reported by the Louisiana Recovery Authority.

The Louisiana State University Agricultural Center estimated total economic losses attributable to Hurricane Katrina to total $1 billion and nearly $600 million to Hurricane Rita.

A number of severe flood events have had their origin with intense rainfall, not related to tropical events. These severe rainfall events have caused significant damage in urban areas in coastal Louisiana, the most severe event in terms of the value of damage associated with rainfall occurred in New Orleans metropolitan area in May of 1995. Rainfall amounts of up to 17.5 inches were reported within a 24-hour period in some areas of Jefferson and Orleans Parishes. Approximately 43,000 residential structures flooded in the region, with insured flood claims totaling nearly $600 million. A combination of intense rainfall and spring floods caused backwater flooding in the city of Morgan City in 1973 and the cities of Houma and Thibodaux in 1991.

Structure Damages Caused by Hurricane Katrina due to Flooding

Hurricane Katrina is attributed to the flooding of 135,000 residential structures and over 12,000 commercial, industrial, and public buildings. The number of vehicles destroyed total over 124,000.

An estimate of direct property and infrastructure damage was published in the 1 June 2006 Final Draft Report by the Interagency Performance Evaluation Team (IPET). This estimate was facilitated~~,~~ with assistance from the New Orleans District, through the development of flood elevation-damage relationships by drainage basin using data utilized from prior studies and by applying these relationships to high-water stage data within an ArcGIS environment.

The damage results from the IPET report were based on the depreciated exposure value data for the residential and non-residential structure occupancies in the five-parish area that were obtained from the general building stock portion of the Hazard—US Multi-Hazard Flood Model (HAZUS-MH), MR1 Release 39 (copyright 2004, FEMA), a multi-hazard loss estimation model developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). A structure inventory was established within the HAZUS-MH program by establishing the aggregate number of square feet within each census block that is allocated to residential properties and to non-residential properties. The model combined data from the 2000 Census and data from the Department of Energy building characteristic reports to assign a total square footage to each of six residential occupancy categories: single-family dwellings, manufactured housing/mobile homes, multi-family dwellings, temporary lodgings, institutional dormitories, and nursing homes. A Dun and Bradstreet database was used to allocate non-residential square footage to each of 27 non-residential occupancies broadly categorized as commercial, industrial, public, and agricultural.

The HAZUS-MH data was used with contents-structure-value ratios and depth-damage relationships developed in support of the Jefferson and Orleans Parishes, LA flood control studies (June 1996) and LIDAR elevation data. These inputs were used in a customized GIS model along with the flood stages associated with Hurricane Katrina for the portions of the 5-parish New Orleans area to calculate the flood damages.

Estimates of direct property losses associated with structures, contents, and vehicles in Orleans, Jefferson, St. Bernard, St. Charles, and Plaquemines Parishes caused by Hurricane Katrina is $20.6 billion. Direct damages to infrastructure were estimated to total $4.6 billion. The IPET also estimated direct property losses under a scenario in which no breaches of floodwalls or levees occur and local pumping stations were assumed to be flood proofed and have a source of back-up electricity in order to keep them fully operational. This scenario resulted in an estimate, exclusive of infrastructure, of $10.2 billion in direct flood damages, which are attributable to overtopping and localized rainfall. Thus, the lack of ‘resilient’ floodwalls and levees and the absence of storm-proofed pumping stations increased the magnitude of direct flood damages from $10.2 billion to $20.6 billion.

Using the stage-damage relationships developed under IPET, the New Orleans District independently evaluated damages under a scenario in which no Federal hurricane protection system was in place for the metropolitan area. Recorded stage data for Hurricane Katrina in adjacent water bodies was used to calculate interior stages and associated flood damages in the area that would be expected if only non-Federal levees were available to protect against storm surge. In absence of the Federal hurricane protection project in the New Orleans metropolitan area, and relying only upon non-Federal levees for flood protection, direct flood damages were estimated to be $45.6 billion, or $25 billion higher than estimated by IPET representing actual damages. The increase in damage is primarily attributable to the wider geographic area that would have been inundated on the east bank of the Mississippi River, primarily areas that were observed to have incurred no flooding as a result of Hurricane Katrina. Again, this estimate does not include damages to infrastructure, but which would significantly exceed the $4.6 billion of actual damages estimated by the IPET.

Application of the flood-damage methodology developed in support of the IPET will be incorporated into the risk and reliability assessment that is expected to form a major component in the plan formulation process as part of the Louisiana Coastal Protection and Restoration Project.

Total Damages Caused by Hurricanes Katrina and Rita (Wind and Flood)

Currently, numerous estimates of damages and economic impacts have been published from an abundance of secondary sources, some verifiable, some not, and always subject to change or on schedule for updates. An attempt is made here to provide estimates that are well-researched from sources that are reasonably authoritative. Some estimates shown below may already have been revised. In time, all estimates are expected to change.

Preliminary Total Damage Estimates

According to the initial damage estimates compiled by the Congressional Budget Office (CBO) and presented to the U.S. House of Representatives Budget Committee in October 2005, the total damage of capital stock for Hurricanes Katrina and Rita ranges from $70 to $130 billion dollars. In aggregate, this range is consistent with the $90 billion preliminary estimate prepared by the New Orleans District and reported in a previous section of this appendix. The CBO damage estimate includes $17 to $33 billion for housing, which includes insured and uninsured homes. Five to $9 billion in damages occurred to consumer durable goods such as automobiles, trucks, and white goods such as kitchen appliances, washers, and dryers. Losses in the energy sector range from $18 to $31 billion, primarily in the form of interrupted crude oil and gas production, damages to petrochemical processing facilities, and electric utilities. The private sector, including medical facilities, hotels, and restaurants, had damages from $16 to $32 billion. Government and public facilities, such as sewage and water infrastructure, port improvements, schools, bridges, airports, and municipal buildings, suffered damages between $13 and $25 billion.

Damages to Residential Property

According to the American Red Cross Damage Assessment surveys, Hurricanes Katrina and Rita affected over 750,000 residential properties in the four-state area of Alabama, Louisiana, Mississippi, and Texas from the effects of flood and wind. These storm-impacted residential properties are classified as single-family dwellings, mobile homes, or apartment buildings which contain several or multiple units. Parishes in Louisiana that incurred flood damage from the two hurricanes include Cameron, Iberia, Jefferson Lafourche, Orleans, Plaquemines, St. Bernard, St. Mary, St. Tammany, Terrebonne, and Vermillion. In Louisiana, 473,182 residential properties incurred wind or flood damage from either or both of the storms. Of this total, approximately 45% either sustained major structural damage or were totally destroyed and 15% received minor structural damage. The structures that were inaccessible at the time of the survey are assumed to have major structural damage. The Insurance Information Institute released data showing that homeowner insurance companies have settled approximately 69% for the hurricane claims in Louisianan as of February 2006 for Hurricanes Katrina and Rita. These claims, which number approximately 479,500 and represent $7.5 billion in losses, average approximately $16,000 for each settlement. These claims are restricted to damages caused by wind, since flood claims are within the domain of the Federal Emergency Management Agency. Ultimately, the institute projects total settled claims to range from $10 to $14 billion.

Damage to Non-Residential Property and Businesses

The Louisiana Recovery Authority (LRA) estimated non-residential damages within a range of $25 to $29 billion. The LRA reported that Hurricanes Katrina and Rita affected 20,544 businesses in Louisiana. Of this total, 18,752, or over 90%, had damages classified as either major or catastrophic. Insurance estimates from Tillinghast Insurance Services found business interruption claims, excluding those from the energy sector, ranged from $6 to $9 billion. (These claims were not included in the estimate of direct damages.) Damages to commercial vehicles are expected to range from $200 million to $300 million. More than 100 oil platforms were destroyed, and 200 oil pipelines were damaged by the two hurricanes. Estimates of oil and gas industry hurricane-related damages, primarily offshore facilities, range between $5 and $10 billion.

Damages to the Public Property

Public sector losses include losses to infrastructure including roads, utilities, and debris removal. According to the LRA, these losses range between $15 billion and $18 billion. Based on data from Entergy New Orleans, Entergy Louisiana, and CLECO, electric service was about 98% below its pre-Katrina level in St. Bernard Parish and over 50% below its pre-Katrina level in both Orleans and Plaquemines Parishes as of February 2006.

State facilities and public/private education and health care facilities have been estimated by the LRA to range from $6 billion to $8 billion. According to the Louisiana Department of

Education, 875 schools were damaged, 40 of which were totally destroyed, by Hurricane Katrina alone. Two of the largest hospitals in the State, Charity Hospital and Tulane Medical Center, remain closed. Approximately 2,623 fewer hospital beds are available in the affected facilities relative to pre-Katrina levels.

Damages to local and Federal flood protection works were initially estimated by the LRA to range from $2 to $4 billion. Total Federal expenditures by Task Force Guardian to restore the hurricane protection system in the New Orleans metropolitan area to pre-Katrina conditions is up to $1.3 billion as of May 2006. Further expenditures have been appropriated by Congress to supplement and reinforce the performance of the current storm protection and drainage systems.

Damages to Agricultural Resources

The Louisiana Agricultural Research Center estimated that the total economic impact of Hurricanes Katrina and Rita, as measured by reduced revenue and increased costs of production, is nearly $1.6 billion. Of this total, Hurricane Katrina accounted for $1 billion and Rita the remainder. Commodities that were adversely impacted include forestry products, agronomic crops (sugarcane, cotton, rice, and soybeans), the fruit/nuts/vegetable/honey industry, livestock and forage, aquaculture, fisheries, and wildlife/recreational. The impact of these storms was primarily to the forestry and agronomic crop sectors (77% for Katrina and 73% for Rita). Fisheries losses represented approximately 10% of the total damages from both storms.

Alternatives to Standard Corps Economic Feasibility Analysis

In planning for coastal storm protection works, heightened interest has been focused on engineering solutions pursued by the Netherlands for possible application in coastal Louisiana. In view of the Congressional guidance for LACPR that excludes the need to perform incremental benefit-cost analysis and plan recommendations based upon the maximization of net national economic development benefits, a similar interest in the Dutch approach to economic analysis is warranted to determine whether it represents an alternative approach that may assist in planning or evaluating LACPR plans.

In sum, the economic theory that the Dutch apply to flood protection works is similar to that established by the U.S. Water Resources Council as codified in the Corps' Planning Principles and Guidelines (ER 1105-2-100). The objective of civil works planning is to enhance the stock of productive assets of the Nation (i.e., to increase national wealth in the form of goods and services) through infrastructure development. As such, these additions to infrastructure represent financial investments in public works, each of which has an expected rate of return, similar to any other form of capital asset. Within the context of plan optimization, the most productive construction plan is one that maximizes net benefits (excess of benefits over costs) for a given array of construction alternatives.

In contrast, maximizing net benefits return is not explicitly part of the Dutch methodology. Rather, the Dutch approach is to minimize what they referred to as total system costs, or, alternatively stated, residual losses. Total system costs are composed of two parts. The first part is the cost of constructing a specific flood control plan that is designed to protect for a discrete flood event as defined by its probability of occurrence. The second part is the economic cost (flood damages) associated with this single event probability that is avoided by the corresponding construction. The economic damage is weighted by the probability of occurrence to yield an expected value for each year during the period of analysis and appropriately discounted to present value. The evaluation of a sufficient number of flood control plans, representing varying levels of design protection, permits the construction of a probability density function representing total system costs for a wide range of flood protection levels. The plan that minimizes these costs is what Dutch refers to as the "economic optimum level of protection." Thus, the Dutch use of the term "cost-benefit analysis" can be viewed as a misnomer when weighed against the more direct method employed in planning studies in the United States.

This approach was developed by D. van Dantzig and formalized in the July 1956 issue of the journal Econometrica under the title of "Economic Decision Problems for Flood Prevention." Since then, a number of refinements have been published in a variety of academic journals, but it has retained its fundamental orientation as an econometric approach to decision-making in contrast to the American approach which relies upon the direct comparison of the discounted, present value of investment costs and benefits.

The early contribution of van Dantzig and others was to focus on the fact that an expected value approach to damage estimation presumes a risk-neutral planning environment, when in fact the persons potentially protected may be highly risk-adverse. The obvious implication is that individuals that benefit from flood protection may willingly trade-off economic efficiency for safety. Perhaps this approach is reflected in the actions of Dutch decision-makers to provide the maximum possible protection to central Holland with the highest concentration of economic development and population, in contrast to outlying, rural planning areas. Beyond this general acknowledgment of the concept of risk-tolerance, the more rigorous treatment of risk and uncertainty as it relates to statistical measurement error of critical hydrologic and economic variables are largely absent in the Dutch approach. In contrast, these advanced concepts are fully incorporated in Corps planning guidance in the form of ER 1105-2-101.

Finally, the Dutch experience has shown that the actual application of the results of economic investigations has been lacking. The viewpoint of decision-makers in the Netherlands is to consider ‘cost-benefit analyses’ strictly in an advisory role. A wide array of non-monetized social effects, political, and environmental considerations are considered in a larger process that facilitates, manages, and elicits consensus-building as the criteria for plan selection for any given region. The near marginalization of economic analysis has been documented in a couple of cases by S.N. Jonkman, M. Brikhuis-Jak, and M. Kok in their academic investigation, “Cost Benefit Analysis and Flood Damage Mitigation in the Netherlands,” appearing in the journal Heron (2004). In contrast, the application of economic principles and practices, including risk-based analysis, is fundamentally institutionalized for the evaluation of public works projects in the United States.

Although there is nothing that is fundamentally new of a theoretical or technical nature in the Dutch approach to evaluating the economic merits of flood protection, the experience that the Dutch have accumulated in reformulating decision-making criteria within a political context to match ever unique situations represents an opportunity to assist project managers and program advocates who are directed to pursue plan formulation in support of LACPR that is exclusive of normal policy considerations.